- New Interdisciplinary Joint Course Offering -

Introduction to Spintronics: Fundamentals and Applications

EEE598 (24910), NAN598 (30464), PHY598 (30465); Tue & Thu 1:30-2:45 pm, ECG-G152

Prof. Richard A. Kiehl (Electrical, Computer and Energy Engineering)
and
Prof. Tingyong Chen (Physics)

Description: The electron's charge has provided the basis for electronic circuitry since the invention of the vacuum tube in the early 1900's and has continued to play the leading role in the physics underlying today's integrated circuits and other modern electronic devices. Yet, it is the electron's *spin* that has provided the most dramatic recent breakthroughs in information technology (not to mention Nobel Prizes!). Many believe that the electron's *spin* offers the most fertile ground for fundamental breakthroughs in computing, signal processing and sensing.

Spintronics represents a new research frontier with the potential to impact a broad range of applications. This course provides an introduction to this subject from an interdisciplinary perspective focused on electrical engineering and physics, together with aspects of materials science and chemistry.

Content: This co-taught interdisciplinary course is designed to be accessible to a wide range of graduate students with different backgrounds in electrical engineering, physics, materials science and chemistry. Students will be introduced to basic concepts and their present and potential use in a broad range of applications. More generally, this course will provide students with an appreciation of how emerging developments in spintronics could intersect with their present interests and future technical work. The list of planned topics for this course includes:

Magnetism (dipole interaction, exchange interaction, types of magnetism)

Magnetoresistance (anomalous Hall effect, spin hall effect, Hanle effect)

Spin transport (spin injection, spin-orbit interaction, spin polarized drift/diffusion)

Spintronic materials and structures (magnetic semiconductors, magnetic nanostructures)

Magnetic switching and oscillation (giant magnetoresistance , spin transfer torque, magnetodynamics)

Spintronic devices (spin transistors, spin torque oscillators, spin LED)

Magnetic-field sensors (hard-drive read heads, biosensors)

Spintronic signal processing and computing (magnetic RAM, mm-wave spintronic components, nanomagnetic logic, all spin logic, computing with spin torque oscillators)

Recommended Prior Studies: Although the material is designed to be as self-contained as possible and tutorials will be available where needed, familiarity with the following subjects is desirable: electromagnetics, elementary quantum mechanics, electronic properties of materials, semiconductor device physics.

Reference Materials and Tools: The course will draw on the specialist's literature on this subject and reference books such as:

"Magnetism and Magnetic Materials," by J. M. D. Coey (2009)

"Nanomagnetism and Spintronics", by Teruya Shinjo (2013)

"Introduction to Spintronics (2nd Ed.)," by Supriyo Bandyopadhyay, Marc Cahay (2015)

Grading Policy: Attendance/Homework (25%), Midterm Exam (25%), Term Paper and Final Presentation (50%). Five homework assignments are planned for the semester.

Further Details: Please contact Professors Richard Kiehl (richard.kiehl@asu.edu) or Tingyong Chen (tingyong.chen@asu.edu) for further details.